



**US Army Corps  
of Engineers**

Waterways Experiment  
Station

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**Preliminary Data Summary  
October 1998  
Field Research Facility**

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# 1 Introduction

The U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. Central to the FRF is the research pier, a reinforced concrete structure which extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the NGVD (1929 National Geodetic Vertical Datum).

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This is a preliminary which provides basic data soon after collection. Since they are preliminary further quality control may be applied to the data and made available via the internet at <http://www.frf.usace.army.mil>. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919)261-6840 ext.222 ([c.baron@cerc.wes.army.mil](mailto:c.baron@cerc.wes.army.mil)).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8 documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 2.

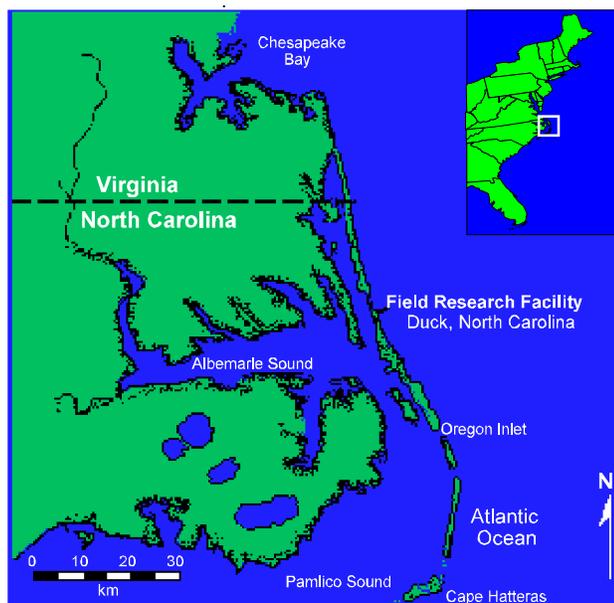


Figure1. FRF Location Map

Times given in the report are referenced to eastern standard time (EST).

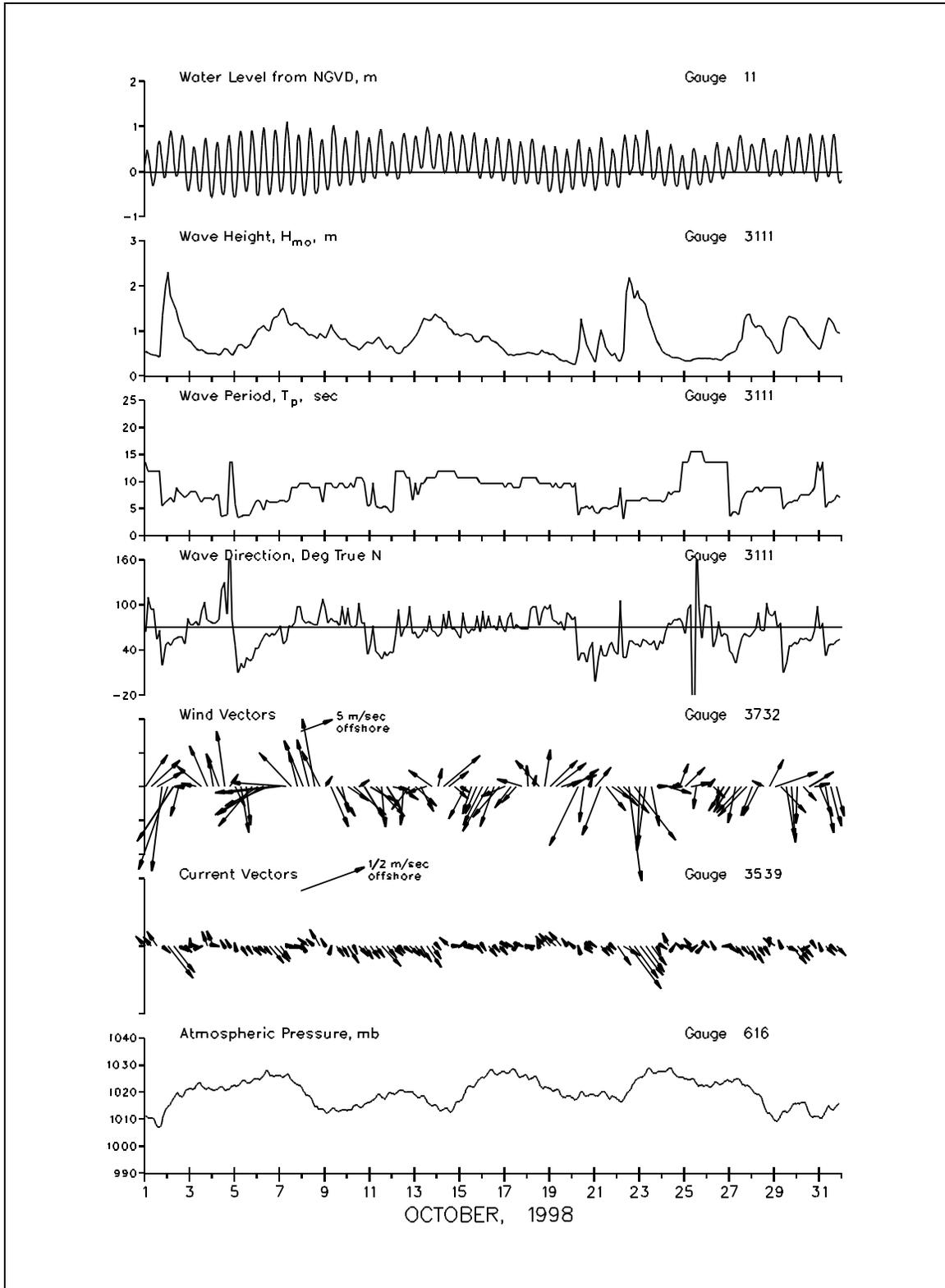


Figure 2. Month at a Glance

**Table 1  
Instrument Status/Data Availability**

		October 1998																																						
		Day of the month																																						
Gauge ID	Description/Remarks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31								
616	Atmospheric Pressure	Gauge Status		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
		Data Collected		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
604	Precipitation	Gauge Status		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
		Data Collected		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
624	Air Temperature	Gauge Status		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
3932	Anemometer	Gauge Status		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
641	Pressure Gauge on FRF pier	Gauge Status		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
625	Baylor staff on FRF pier	Gauge Status		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3111	8 Meter Array 309 m north of FRF	Gauge Status		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
111	Pressure Gauge center of 8 Meter Array	Gauge Status		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
630	Waverider buoy 4.0 km offshore	Gauge Status		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	NOAA tide gauge at end of pier	Gauge Status		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Visual Observations (daily oceanographic and meteorological observations)	Daily observation		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
	Gauge Status			*	=	/	=	-	=																															
	Data Collected			*	=	/	=	-	=																															
	Visual Observations			*	=	/	=	-	=																															

Table 2 Gauge Locations							
Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates		Gauge Depth NGVD, m	Water Depth NGVD, m
				Crossshore m	Longshore m		
616	Atmospheric Pressure	36 10' 57.03"	75 45' 5.50"	11.60	569.00	-----	-----
3932	Anemometer	36 11' 1.23"	75 44' 43.07"	585.20	517.30	19.50	-----
641	Pressure Gauge	36 10' 57.71"	75 44' 56.23"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11' 1.04"	75 44' 43.72"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11' 19.14"	75 44' 36.41"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11' 11.28"	75 44' 33.28"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11' 13.70"	75 44' 32.56"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11' 12.48"	75 44' 37.11"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11' 14.06"	75 44' 34.39"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 10' 5.10"	75 41' 59.30"	3934.96	-2400.81	Surface	-17.00
3539	Current Meter	36 11' 23.57"	75 44' 9.12"	1605.80	907.60	-11.60	-11.70
11	NOAA Tide Gauge	36 11' 1.25"	75 44' 42.60"	596.49	514.20	Surface	-7.62

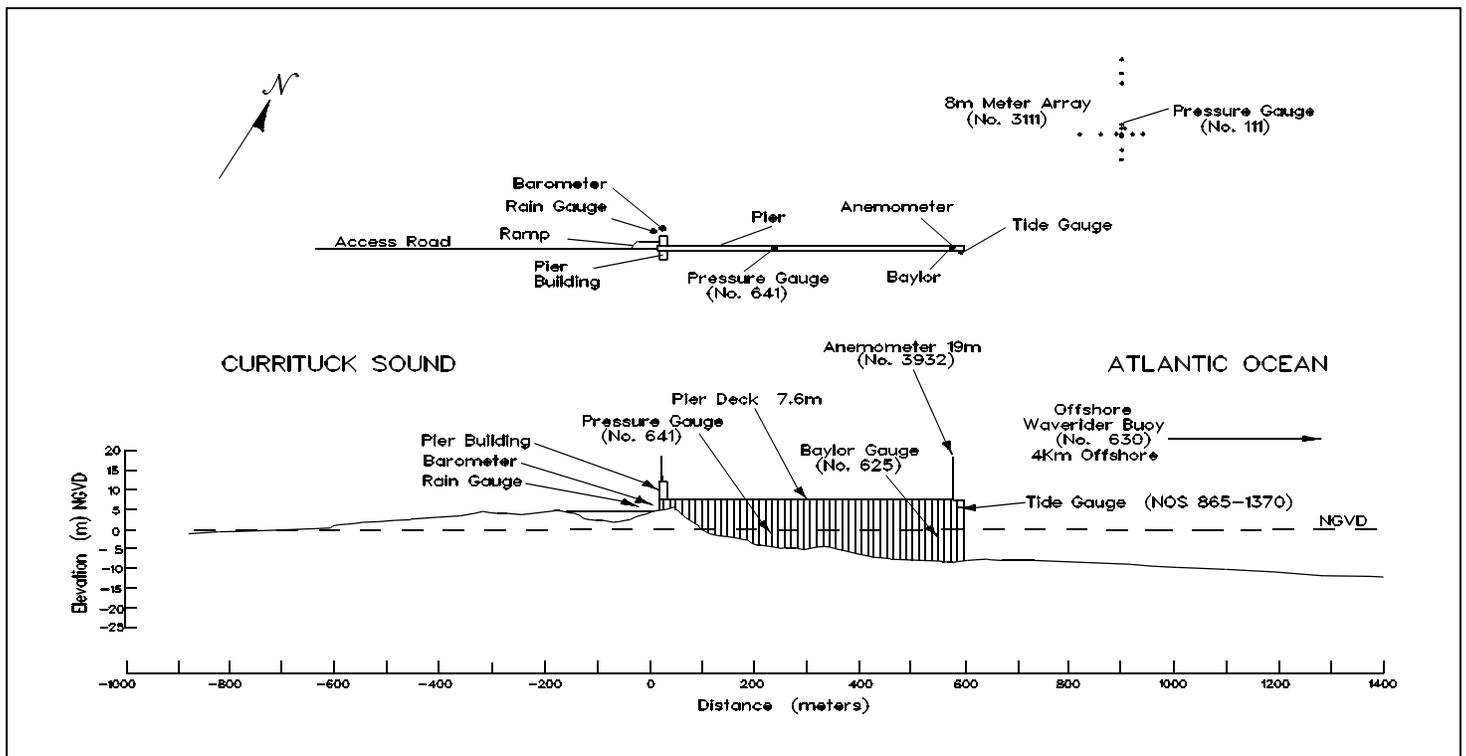


Figure 3. Instrument Locations, Elevations From NGVD

## 2 Meteorological Data

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A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -  
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -  
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(\text{C} \times 9/5) + 32 = \text{F}$
4. Meters per second (m/s) to knots (kn) -  
 $\text{m/s} \times 1.943 = \text{kn}$

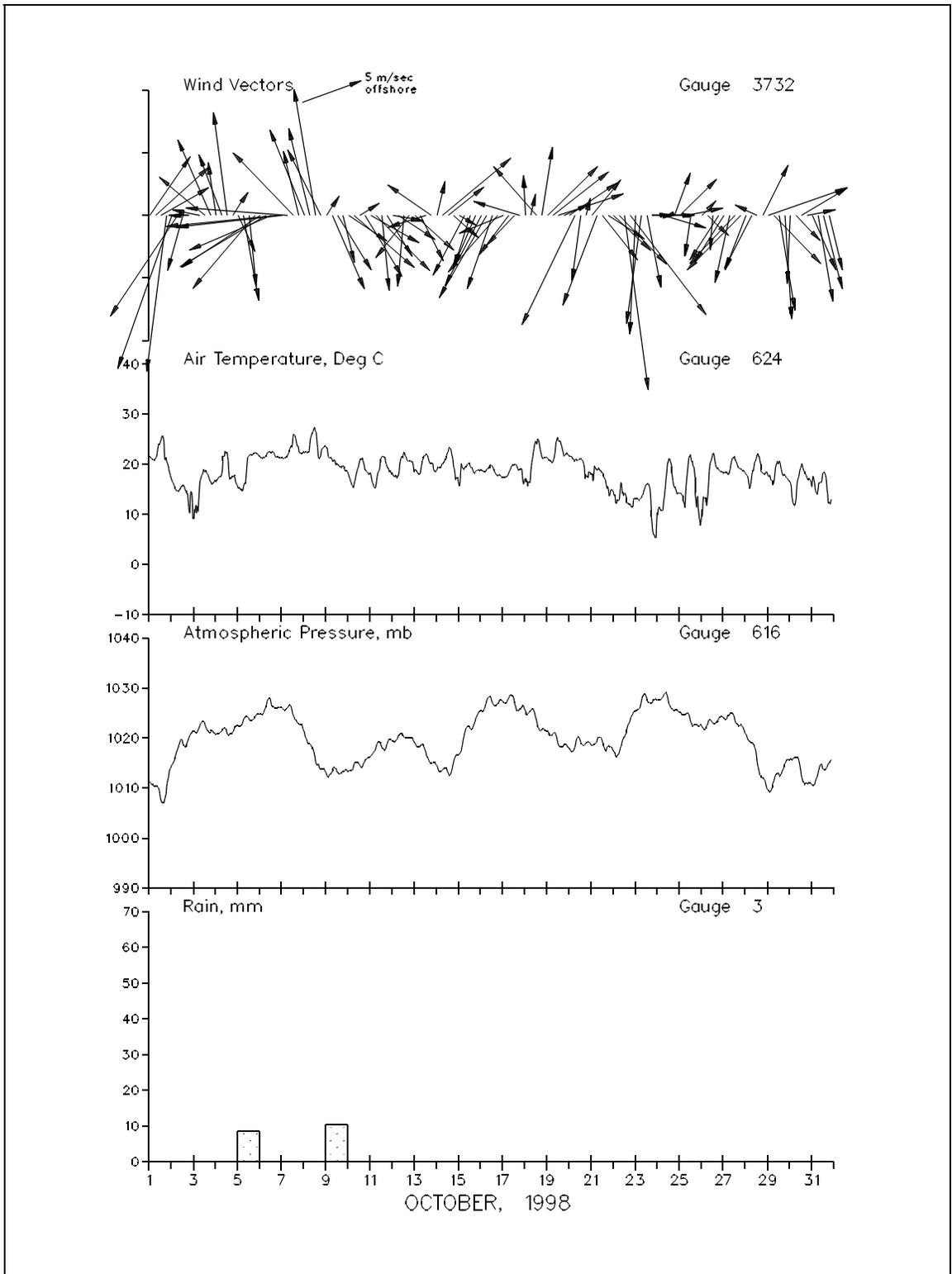


Figure 4. Meteorological Monthly Summary

**Table 3  
Meteorological Data**

Oct 1998						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	6	214	21.5	1011.3	0
	700	6	227	21.1	1010.4	0
	1300	4	239	24.8	1007.6	0
	1900	13	7	20.6	1010.3	0
2	100	13	19	16.8	1014.7	0
	700	10	33	14.7	1017.8	0
	1300	5	15	15.8	1018.9	0
	1900	2	90	11.4	1020.0	0
3	100	1	81	9.1	1021.5	0
	700	2	101	16.3	1022.5	0
	1300	5	129	18.5	1022.6	0
	1900	7	156	16.5	1021.2	0
4	100	4	171	16.5	1020.8	0
	700	5	159	18.2	1021.4	0
	1300	8	172	22.5	1020.9	0
	1900	2	212	17.7	1021.3	0
5	100	3	334	15.2	1022.5	0
	700	7	350	15.5	1023.7	9
	1300	6	354	21.8	1023.7	0
	1900	8	40	22.3	1024.1	0
6	100	8	56	21.4	1024.9	0
	700	8	58	21.7	1026.3	0
	1300	7	66	22.4	1026.8	0
	1900	9	84	21.5	1026.0	0
7	100	9	83	21.4	1026.1	0
	700	8	94	21.9	1026.2	0
	1300	7	136	26.0	1024.5	0
	1900	5	166	23.0	1022.9	0
8	100	7	158	22.3	1021.1	0
	700	7	166	23.9	1018.9	0
	1300	10	170	26.6	1015.4	0
	1900	6	153	21.9	1014.0	0
9	100	2	211	23.3	1012.7	0
	700	6	336	20.7	1013.4	10
	1300	5	328	19.9	1013.1	0
	1900	4	346	19.7	1013.5	0
10	100	4	303	17.8	1013.4	0
	700	6	310	15.9	1014.8	0
	1300	2	237	20.7	1014.6	0
	1900	6	328	18.9	1015.6	0

**Table 3  
Meteorological Data (continued)**

Oct 1998						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	4	299	18.1	1016.5	0
	700	6	315	16.0	1018.3	0
	1300	6	354	21.5	1018.1	0
	1900	4	328	19.5	1018.9	0
12	100	2	279	17.9	1019.5	0
	700	4	303	17.7	1020.5	0
	1300	6	5	22.3	1020.3	0
	1900	4	38	20.8	1020.1	0
13	100	4	311	19.0	1019.0	0
	700	4	333	18.3	1018.5	0
	1300	3	72	22.0	1017.0	0
	1900	4	125	20.2	1015.1	0
14	100	3	193	19.0	1014.5	0
	700	7	229	20.2	1013.6	0
	1300	4	231	22.5	1013.1	0
	1900	3	311	19.8	1015.1	0
15	100	2	299	15.6	1016.8	0
	700	5	27	19.2	1021.0	0
	1300	4	17	19.6	1022.0	0
	1900	4	23	18.5	1023.9	0
16	100	6	27	18.8	1025.5	0
	700	8	29	18.9	1027.5	0
	1300	6	19	19.6	1027.1	0
	1900	6	41	17.7	1027.0	0
17	100	4	67	17.4	1027.2	0
	700	4	37	18.2	1028.1	0
	1300	3	43	19.8	1027.3	0
	1900	4	106	18.9	1025.9	0
18	100	3	177	17.1	1025.4	0
	700	2	192	18.6	1025.5	0
	1300	5	138	24.1	1023.5	0
	1900	6	188	21.5	1021.8	0
19	100	6	225	21.2	1021.4	0
	700	6	231	20.5	1020.9	0
	1300	5	251	24.7	1018.7	0
	1900	2	245	21.7	1018.8	0
20	100	5	235	21.7	1018.0	0
	700	10	26	20.7	1018.3	0
	1300	5	7	21.2	1019.2	0
	1900	1	194	17.8	1019.1	0

**Table 3  
Meteorological Data (concluded)**

Oct 1998						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	4	219	18.1	1018.6	0
	700	8	20	18.9	1019.7	0
	1300	5	321	18.4	1019.3	0
	1900	3	302	15.2	1018.5	0
22	100	4	313	14.3	1017.5	0
	700	5	315	12.9	1017.2	0
	1300	14	352	14.1	1020.3	0
	1900	10	322	11.9	1023.7	0
23	100	10	2	13.1	1025.6	0
	700	9	7	13.3	1027.3	0
	1300	6	348	16.0	1027.9	0
	1900	2	267	7.2	1027.3	0
24	100	3	269	9.8	1027.7	0
	700	4	286	12.2	1028.6	0
	1300	1	68	21.1	1027.0	0
	1900	4	200	15.3	1025.7	0
25	100	4	225	14.3	1025.2	0
	700	3	259	14.0	1024.8	0
	1300	3	8	21.4	1023.2	0
	1900	3	154	11.4	1022.8	0
26	100	2	223	11.0	1022.4	0
	700	2	313	13.4	1022.8	0
	1300	3	4	22.2	1023.0	0
	1900	4	32	18.9	1024.0	0
27	100	4	32	18.3	1024.0	0
	700	6	12	18.7	1024.9	0
	1300	5	43	20.9	1023.5	0
	1900	6	44	19.0	1022.6	0
28	100	5	21	18.0	1020.8	0
	700	5	27	17.8	1019.2	0
	1300	2	115	21.9	1015.4	0
	1900	5	206	18.3	1012.1	0
29	100	7	250	17.7	1009.7	0
	700	5	315	16.4	1011.5	0
	1300	8	350	20.6	1012.6	0
	1900	8	356	17.8	1015.0	0
30	100	5	2	16.3	1015.9	0
	700	3	316	13.1	1016.2	0
	1300	4	238	19.9	1012.6	0
	1900	2	258	17.3	1011.0	0
31	100	5	336	16.8	1010.6	0
	700	7	350	15.1	1013.1	0
	1300	6	345	18.3	1013.7	0
	1900	5	346	12.3	1015.1	0
		Resultant		Mean	Mean	Total
		2	356	18.5	1019.9	19

## 3 Wave Data

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Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 Hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height  $H_{mo}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all  $H_{mo}$  and  $T_p$  values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

**Table 4**  
**Wave Data**

Oct 1998										
Day	Hour	641		625		3111			630	
		Pressure Gauge Hmo,m	Tp,sec	Baylor Gauge Hmo,m	Tp,sec	8 Meter Array Hmo,m	Tp,sec	Dir,TN	Waverider Hmo,m	Tp,sec
1	0100	0.30	13.5	0.50	12.9	0.56	13.6	64	0.68	13.4
	0700	0.25	12.2	0.47	12.9	0.48	12.0	94	0.60	13.4
	1300	0.31	6.1	0.39	12.2	0.46	12.0	54	0.61	11.2
	1900	0.66	4.1	1.34	4.9	1.35	5.6	20	0.76	11.2
2	0100	1.49	6.5	1.96	6.6	2.30	6.6	50	2.56	6.7
	0700	1.17	6.1	1.44	5.9	1.61	6.2	54	1.74	5.9
	1300	0.95	7.8	1.21	8.0	1.23	8.2	58	1.52	8.4
	1900	0.65	7.0	0.81	7.0	0.86	7.1	48	1.04	7.7
3	0100	0.42	5.9	0.76	7.0	0.78	8.2	74	0.94	6.7
	0700	0.38	5.9	0.54	9.2	0.62	8.2	78	0.69	7.2
	1300	0.34	5.5	0.57	6.6	0.59	6.2	92	0.72	6.7
	1900	0.38	6.3	0.51	7.2	0.51	7.1	80	0.69	7.2
4	0100	0.27	3.3	0.50	8.3	0.51	6.6	76	0.66	5.9
	0700	0.33	3.7	0.47	8.1	0.48	7.6	80	0.60	3.8
	1300	0.37	3.4	0.60	3.8	0.61	3.8	130	0.75	3.6
	1900	0.36	12.9	0.46	4.4	0.52	13.6	210	0.59	4.1
5	0100	0.31	5.9	0.52	5.9	0.58	5.9	46	0.64	6.3
	0700	0.50	3.8	0.62	3.6	0.71	3.6	22	0.84	4.8
	1300	0.47	3.8	0.59	4.0	0.63	3.9	30	0.79	4.4
	1900	0.63	5.5	0.74	4.7	0.83	5.0	28	0.87	4.6
6	0100	0.66	6.5	0.92	6.0	1.05	6.6	42	1.06	4.8
	0700	0.88	4.6	1.00	4.1	1.12	4.8	58	1.29	5.9
	1300	0.61	5.2	0.95	6.5	1.00	6.2	58	1.22	6.3
	1900	0.99	5.4	1.21	6.1	1.31	6.2	60	1.46	5.9
7	0100	0.74	4.5	1.34	7.0	1.46	6.6	72	1.55	5.6
	0700	1.13	5.4	1.35	6.0	1.38	6.2	52	1.58	6.7
	1300	0.60	6.0	1.05	7.0	1.12	8.9	70	1.28	7.2
	1900	0.81	8.9	1.05	8.9	1.17	8.9	98	1.32	9.1
8	0100	0.59	5.0	0.93	8.9	1.07	9.8	80	1.37	8.4
	0700	0.67	4.7	0.83	8.9	0.92	9.8	78	1.07	9.1
	1300	0.59	5.2	0.81	9.2	0.89	8.9	74	1.09	8.4
	1900	0.67	6.0	0.78	8.1	0.95	8.9	90	1.05	8.4
9	0100	0.55	7.0	0.79	7.2	0.84	9.8	96	0.99	7.2
	0700	0.81	4.6	1.01	9.2	1.15	9.8	82	1.28	6.7
	1300	0.64	4.4	0.77	10.7	0.92	8.9	78	1.03	10.1
	1900	0.52	8.3	0.73	9.2	0.83	9.8	98	1.03	8.4
10	0100	0.51	7.8	0.70	8.3	0.75	8.9	96	0.87	9.1
	0700	0.49	3.9	0.65	10.3	0.67	8.9	70	0.88	7.7
	1300	0.44	10.7	0.54	10.7	0.58	10.8	102	0.67	10.6
	1900	0.49	4.2	0.67	9.5	0.70	9.8	76	0.94	10.1

**Table 4**  
**Wave Data (continued)**

Oct 1998										
Day	Hour	641		625		3111			630	
		Pressure Gauge	Baylor Gauge	8 Meter Array		Waverider				
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
11	0100	0.61	5.6	0.64	5.6	0.74	5.9	48	0.90	10.1
	0700	0.57	5.1	0.69	9.2	0.81	5.6	38	1.00	5.6
	1300	0.75	5.5	0.77	5.5	0.78	5.3	28	0.98	5.6
	1900	0.43	5.4	0.57	5.2	0.61	5.3	32	0.80	4.6
12	0100	0.52	5.6	0.59	5.0	0.65	4.6	36	0.74	5.1
	0700	0.35	6.0	0.49	11.7	0.51	12.0	94	0.57	11.2
	1300	0.46	9.2	0.59	11.2	0.64	12.0	68	0.67	11.2
	1900	0.45	5.9	0.66	8.9	0.72	10.8	98	0.82	5.9
13	0100	0.55	5.7	0.73	10.7	0.88	9.8	64	0.92	8.4
	0700	0.70	10.7	1.01	10.3	1.15	9.8	60	1.20	10.1
	1300	0.86	9.9	1.21	10.3	1.27	10.8	64	1.34	9.1
	1900	0.78	11.7	1.16	11.2	1.27	10.8	66	1.21	10.1
14	0100	0.83	12.9	1.15	11.7	1.32	12.0	58	1.36	11.2
	0700	0.62	12.2	1.05	12.2	1.22	12.0	88	1.08	11.8
	1300	0.61	10.7	0.91	11.7	1.07	12.0	92	1.14	11.8
	1900	0.48	11.7	0.84	11.2	0.93	12.0	68	0.98	11.8
15	0100	0.51	10.7	0.82	11.2	0.89	10.8	56	0.94	11.2
	0700	0.57	11.2	0.85	10.3	0.95	10.8	68	1.03	10.6
	1300	0.57	10.7	0.84	10.7	0.92	10.8	68	1.06	10.6
	1900	0.45	10.3	0.66	10.7	0.77	10.8	86	0.85	10.6
16	0100	0.54	3.9	0.77	10.3	0.88	9.8	92	0.90	10.1
	0700	0.61	4.3	0.82	9.9	0.88	9.8	86	1.01	10.1
	1300	0.50	4.2	0.76	4.2	0.78	9.8	72	0.87	4.2
	1900	0.48	4.5	0.68	9.5	0.67	9.8	86	0.89	4.6
17	0100	0.35	4.9	0.53	9.2	0.55	8.9	64	0.71	9.1
	0700	0.31	9.5	0.45	9.2	0.48	9.8	90	0.59	9.1
	1300	0.26	5.4	0.51	8.6	0.48	8.9	74	0.54	9.1
	1900	0.30	11.2	0.46	8.1	0.50	10.8	68	0.54	9.1
18	0100	0.25	11.2	0.54	10.3	0.53	10.8	68	0.61	11.2
	0700	0.29	10.7	0.45	11.2	0.50	10.8	98	0.54	10.6
	1300	0.21	9.9	0.50	9.2	0.50	9.8	72	0.51	10.1
	1900	0.33	10.7	0.48	10.3	0.52	9.8	98	0.66	10.1
19	0100	0.21	15.1	0.48	9.9	0.49	9.8	100	0.64	10.6
	0700	0.27	8.9	0.38	9.5	0.44	9.8	78	0.64	10.6
	1300	0.13	9.9	0.34	9.9	0.36	8.9	78	0.43	10.1
	1900	0.22	9.9	0.30	9.9	0.34	9.8	90	0.34	11.2
20	0100	0.14	10.7	0.27	9.5	0.28	8.9	80	0.34	10.6
	0700	0.25	2.4	0.29	9.5	0.60	3.8	26	0.35	10.6
	1300	0.71	5.5	0.98	5.5	0.96	5.3	36	1.34	5.6
	1900	0.49	5.1	0.54	5.3	0.58	5.0	42	0.76	5.3

**Table 4**  
**Wave Data (concluded)**

Oct 1998										
Day	Hour	641		625		3111			630	
		Pressure Hmo,m	Gauge Tp,sec	Baylor Hmo,m	Gauge Tp,sec	8 Meter Hmo,m	Array Tp,sec	Dir, TN	Waverider Hmo,m	Tp,sec
21	0100	0.22	5.4	0.31	4.6	0.31	4.4	358	0.43	5.1
	0700	0.85	4.9	1.00	5.1	1.03	5.0	46	1.16	4.8
	1300	0.51	5.3	0.72	5.3	0.63	5.3	32	0.91	5.3
	1900	0.38	4.7	0.42	5.3	0.46	5.3	50	0.61	4.8
22	0100	0.27	5.5	0.38	5.7	0.37	5.6	34	0.59	5.9
	0700	0.27	5.6	0.32	9.5	0.56	3.2	30	0.49	9.1
	1300	1.10	7.0	2.01	6.8	2.19	6.6	52	2.55	6.7
	1900	1.33	7.0	1.58	6.6	1.73	6.6	48	2.25	6.3
23	0100	1.06	7.0	1.68	6.8	1.72	6.6	44	2.19	6.7
	0700	1.32	7.0	1.45	7.2	1.58	7.1	52	1.74	7.2
	1300	0.87	6.8	1.09	7.0	1.12	6.6	48	1.32	7.2
	1900	0.66	6.5	0.71	6.5	0.79	6.6	40	1.02	6.7
24	0100	0.39	6.1	0.57	7.0	0.54	6.2	48	0.67	6.7
	0700	0.30	5.9	0.41	7.8	0.47	8.2	76	0.55	5.9
	1300	0.24	15.1	0.41	8.6	0.41	8.2	80	0.46	8.4
	1900	0.20	14.3	0.35	14.3	0.41	8.2	82	0.42	7.2
25	0100	0.20	16.0	0.36	13.5	0.35	13.6	62	0.41	8.4
	0700	0.22	14.3	0.32	12.9	0.35	15.7	100	0.35	13.4
	1300	0.24	16.0	0.32	16.0	0.39	15.7	200	0.37	15.4
	1900	0.24	15.1	0.39	13.5	0.41	15.7	56		
26	0100	0.24	14.3	0.34	13.5	0.39	13.6	98	inoperative	
	0700	0.24	14.3	0.34	13.5	0.38	13.6	44		
	1300	0.24	13.5	0.32	14.3	0.37	13.6	78	0.45	8.3
	1900	0.35	2.9	0.50	12.2	0.42	13.6	62	0.58	8.4
27	0100	0.35	3.5	0.47	3.4	0.51	3.6	38	0.54	13.4
	0700	0.38	4.7	0.53	4.6	0.56	4.4	22	0.63	11.8
	1300	0.65	5.7	0.72	4.2	0.81	6.6	56	0.96	4.2
	1900	0.81	7.8	1.25	7.8	1.37	8.2	60	1.49	7.2
28	0100	0.79	8.3	1.10	8.1	1.17	8.2	62	1.42	7.7
	0700	0.58	8.9	1.04	8.3	1.13	8.9	90	1.14	10.1
	1300	0.61	8.3	0.94	9.2	1.01	8.9	66	1.23	10.1
	1900	0.39	8.8	0.82	9.5	0.83	8.9	88	0.95	8.4
29	0100	0.34	9.2	0.55	8.6	0.61	8.9	92	0.78	9.1
	0700	0.29	2.8	0.52	8.6	0.56	8.9	76	0.63	9.1
	1300	1.02	6.0	1.12	5.7	1.25	5.9	24	1.41	5.6
	1900	0.85	6.1	1.17	6.3	1.31	6.2	46	1.52	6.3
30	0100	1.06	6.8	1.11	6.5	1.23	6.6	48	1.45	7.2
	0700	0.72	6.0	0.96	7.6	1.06	7.6	54	1.26	7.7
	1300	0.65	7.2	0.83	8.1	0.86	7.6	52	1.03	6.7
	1900	0.49	7.2	0.68	8.9	0.72	8.9	66	0.76	8.4
31	0100	0.41	13.5	0.57	12.9	0.60	12.0	68	0.60	12.6
	0700	0.79	5.0	0.94	5.1	1.11	5.3	32	1.15	5.1
	1300	0.98	6.3	1.18	6.8	1.24	6.2	48	1.44	6.3
	1900	0.78	6.5	0.94	7.2	0.99	7.6	52	1.23	7.1
Mean		0.54	7.6	0.75	8.5	0.82	8.5	69	0.95	8.2

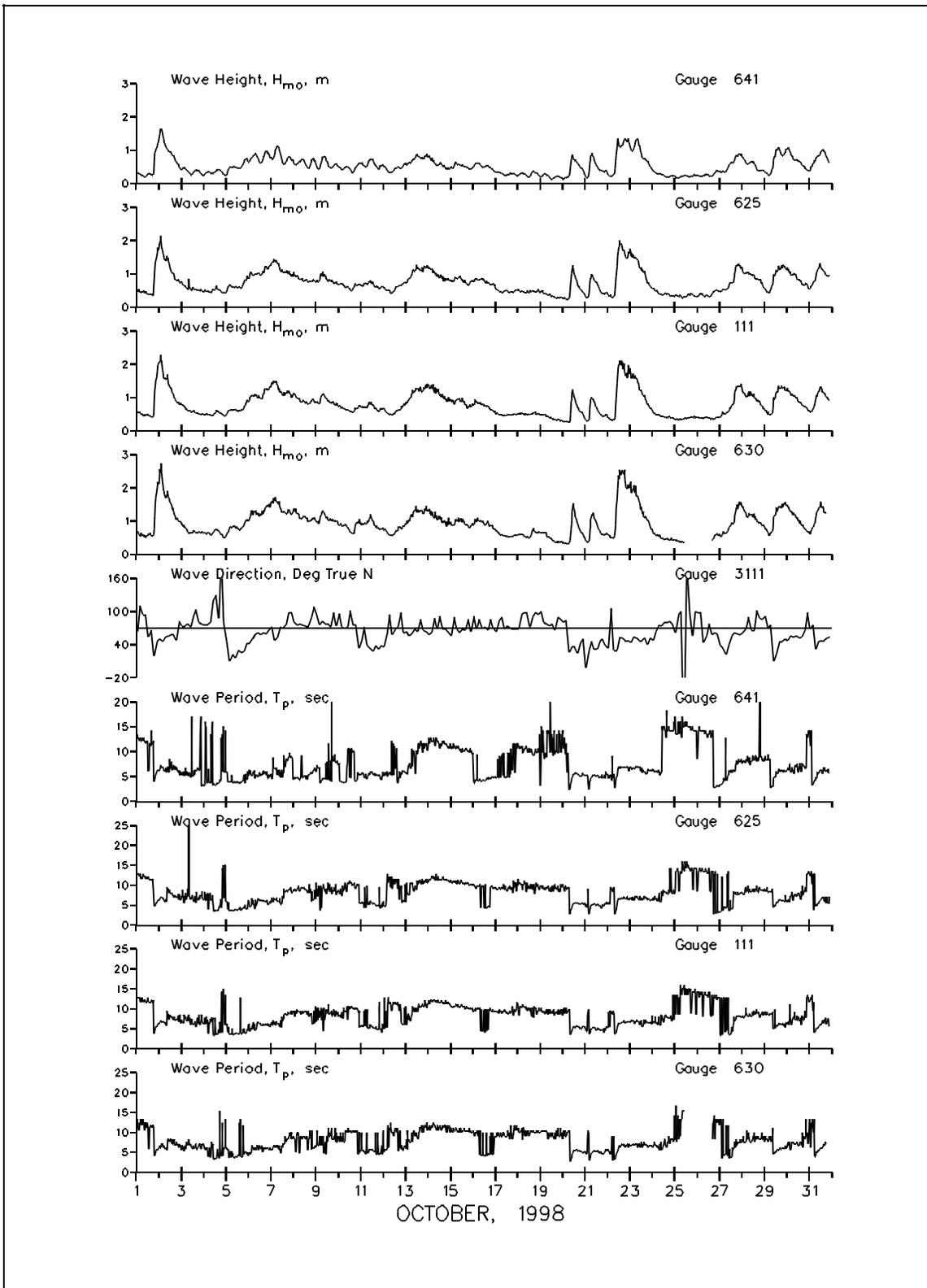


Figure 5. Wave Heights and Periods

## 4 Current Data

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Current data (Table 5) are collected from a Sontek acoustic current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

**Table 5**  
**Current Meter Data - Gauge 3539**

OCTOBER 1998

Cross Long					Cross Long					Cross Long							
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100	5	-8	10	314	1300	-8	19	21	136	22	100	-3	17	17	146	
	700	3	-8	9	320	1900	-2	11	11	143		700	-8	11	14	119	
	1300	3	-12	13	327	12	100	-4	9	10	132	1300	-11	38	39	143	
	1900	-3	6	8	129		700	-2	7	7	139	1900	-7	28	29	144	
2	100	-8	29	30	142	1300	-3	7	8	129	23	100	-7	26	27	142	
	700	-7	24	25	142	1900	-4	9	11	133		700	-5	23	24	144	
	1300	-4	6	8	119	13	100	-3	10	11	139	1300	-4	17	18	143	
	1900	-2	6	7	130		700	-2	14	14	147	1900	0	8	8	161	
3	100	-1	-5	6	356	1300	-4	19	19	145	24	100	-1	3	4	125	
	700	-1	1	3	101	1900	-2	11	12	145		700	1	-9	11	336	
	1300	0	0	0		14	100	0	4	4	140	1300	-1	0	2	34	
	1900	0	-11	12	341		700	inoperative			1900	2	-2	4	308		
4	100	1	-11	12	338	1300	5	-7	10	311	25	100	2	-1	3	288	
	700	0	1	1	100	1900	-4	2	5	91		700	3	-6	8	320	
	1300	1	-5	6	328	15	100	2	1	2	235	1300	0	0	0		
	1900	1	-5	6	329		700	-4	4	6	110	1900	0	0	0		
5	100	0	-2	3	347	1300	-3	2	4	98	26	100	0	2	2	132	
	700	-1	8	9	146	1900	-1	7	7	143		700	1	-3	4	330	
	1300	-1	7	8	142	16	100	0	4	5	146	1300	inoperative				
	1900	-3	9	9	137		700	-2	10	10	141	1900	2	0	2	265	
6	100	-3	7	8	131	1300	-2	6	6	136	27	100	-3	7	8	129	
	700	-3	8	9	135	1900	-2	8	9	140		700	-2	9	10	142	
	1300	-5	16	17	140	17	100	0	2	2	131	1300	-3	8	9	135	
	1900	-5	15	16	136		700	-1	1	2	112	1900	-2	12	12	147	
7	100	-3	12	12	143	1300	-2	0	3	44	28	100	-2	14	15	148	
	700	-7	5	10	98	1900	0	1	1	112		700	-1	8	9	146	
	1300	-1	1	3	94	18	100	2	-1	3	304	1300	-1	8	8	147	
	1900	2	-1	3	288		700	0	0	0		1900	0	1	1	180	
8	100	0	-1	2	334	1300	0	-5	6	348	29	100	6	-8	11	304	
	700	6	-7	10	306	1900	4	-8	10	319		700	0	-4	5	337	
	1300	4	-6	8	313	19	100	5	-11	13	319	1300	-6	7	10	113	
	1900	3	-13	14	329		700	5	-9	11	315	1900	-5	16	17	141	
9	100	1	-6	7	330	1300	5	-12	14	320	30	100	-4	13	14	140	
	700	0	0	0		1900	2	-6	7	326		700	-3	10	11	138	
	1300	-2	9	10	145	20	100	2	-3	5	311	1300	0	0	0		
	1900	-1	9	10	149		700	0	0	0		1900	0	2	2	146	
10	100	-2	15	15	148	1300	-3	7	8	128	31	100	0	-2	3	340	
	700	0	7	7	155	1900	-1	3	3	129		700	-3	9	10	134	
	1300	-3	9	10	139	21	100	0	1	2	122	1300	-2	5	6	129	
	1900	-1	11	11	148		700	-3	9	10	138	1900	-3	9	10	138	
11	100	-2	11	12	143	1300	-2	7	8	138							
	700	-2	10	10	144	1900	-1	4	4	131							

KEY:

+cross-shore = offshore, cm/sec  
 -cross-shore = onshore, cm/sec  
 +longshore = south, cm/sec  
 -longshore = north, cm/sec  
 Speed = Resultant speed, cm/sec  
 Dir = Resultant direction, degrees true north

**Table 6**  
**Visually Observed Current Data**

Oct 1998												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	-19	-32	37	309	-20	-68	71	323	North	23	N	
2	-20	68	71	177	-46	152	159	177	North	71	S	
3	-2	-9	9	326	27	-27	37	25	South	9	N	
4	-9	-29	30	323	0	-47	47	340	South	38	N	
5	0	61	61	160	6	41	41	151	North	16	S	
6	-10	32	33	177	0	68	68	160	North	18	S	
7	-22	24	33	250	11	-76	77	349	North	12	N	
8	0	-61	61	340	-18	-122	123	331	North	35	N	
9	0	36	36	160	0	-102	102	340	North	28	S	
10	0	61	61	160	-23	-76	80	323	North	21	S	
11	0	44	44	160	0	51	51	160	North	23	S	
12	8	28	29	143	-8	-55	56	331	North	14	S	
13	11	55	57	149	-26	-44	51	309	North	7	S	
14	34	-21	40	38	0	-122	122	340	North	18	N	
15	-20	34	39	191	-4	15	15	250	North	12	S	
16	0	76	76	160	0	102	102	160	North	35	S	
17	-16	27	31	250	-7	-14	16	313	South	11	N	
18	9	-9	13	25	-12	-41	42	323	South	20	N	
19	30	-25	40	30	-30	-102	106	323	North	10	N	
20	-20	68	71	177	-61	102	118	191	North	77	S	
21	-9	87	88	166	-18	122	123	169	North	68	S	
22	0	51	51	160	5	34	34	151	North	21	S	
23	0	87	87	160	0	122	122	160	North	84	S	
24	5	17	18	70	19	25	32	70	North	12	S	
25	0	-30	30	340	4	23	24	70	North	4	N	
26	0	-29	29	340	0	-76	76	340	North	15	N	
27	-13	44	45	177	20	34	39	129	North	34	S	
28	-4	25	26	169	-29	32	43	250	North	10	S	
29	19	16	25	110	11	18	21	70	North	15	S	
30	-4	29	29	169	-23	76	80	177	North	18	S	
31	-4	44	44	166	-8	76	77	166	North	39	S	

KEY:  
+cross-shore = offshore, cm/sec  
-cross-shore = onshore, cm/sec  
+longshore = south, cm/sec  
-longshore = north, cm/sec  
Speed = Resultant speed, cm/sec  
Dir = Resultant direction, degrees true north

## 5 Visual Observations

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Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

**Table 7**  
**Visual Observations**

Oct 1998							
Day	Time	Wave Approach Angle at Pier End (degrees from True N)		Surf Zone Width, m	Water Characteristics at Pier End		
		Primary	Secondary		Temp., C	Density g/cc	Secchi Vis., m
1	0705	120		66	23.3	1.0207	0.9
2	0600	20		90	21.7	1.0213	0.6
3	0840	90	30	62	21.7	1.0220	0.3
4	1015	130		69	22.8	1.0227	0.3
5	0600	0		32	22.8	1.0213	0.9
6	0640	30		84	21.9	1.0212	0.9
7	0640	70		87	22.2	1.0198	1.8
8	0550	120	80	77	22.2	1.0205	1.2
9	0640	10		78	22.2	1.0212	0.6
10	0800	0		57	21.7	1.0211	0.3
11	0700	10		55	21.7	1.0208	0.6
12	0900	20		33	21.1	1.0195	1.5
13	0630	30		98	21.1	1.0191	1.8
14	0650	70		150	21.1	1.0193	1.2
15	0650	20		91	21.4	1.0199	1.2
16	0555	20	350	71	20.6	1.0197	1.2
17	0620	40		18	20.6	1.0202	2.4
18	0754	90		31	20.6	1.0202	2.4
19	0925	120		40	21.7	1.0209	1.2
20	0820	0		73	21.1	1.0213	1.2
21	0705	0		65	20.0	1.0212	0.6
22	0700	0		24	19.4	1.0207	2.7
23	0625	0		110	17.8	1.0201	0.6
24	0535	30	10	40	17.2	1.0198	1.2
25	0830	80		24	18.3	1.0206	1.2
26	0615	80		30	18.1	1.0204	2.7
27	0645	20		61	19.2	1.0205	1.5
28	0650	60	20	101	18.9	1.0205	0.9
29	0650	90	0	77	18.9	1.0211	0.9
30	0750	40		105	18.3	1.0209	1.5
31	0930	30		55	17.8	1.0215	1.2

## 6 Water Levels

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Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

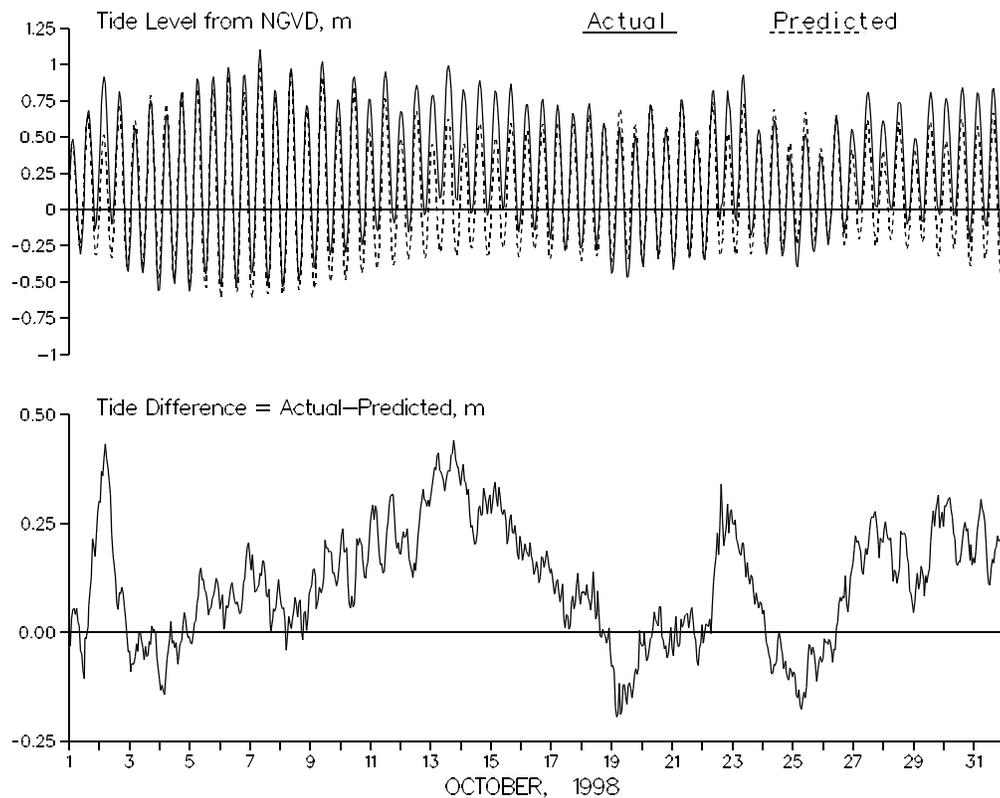


Figure 6. Water Level Variation

**Table 8**  
**Water Levels, m NGVD**

OCT 1998 Tide Levels															
Day	High		Day	Low		Mean m	Range m	Day	High		Day	Low		Mean m	Range m
	Time	m		Time	m				Time	m		Time	m		
1	0248	0.50	1	0900	-0.31	0.11	0.81	16	1648	0.77	16	2318	-0.21	0.28	0.98
1	1600	0.68	1	2048	-0.14	0.28	0.83	17	0454	0.73	17	1054	-0.28	0.22	1.01
2	0412	0.93	2	1000	-0.10	0.42	1.04	17	1718	0.69	17	2324	-0.29	0.20	0.98
2	1612	0.82	2	2236	-0.46	0.20	1.28	18	0524	0.75	18	1142	-0.28	0.24	1.03
3	0436	0.58	3	1118	-0.45	0.08	1.03	18	1830	0.61	19	0018	-0.46	0.08	1.07
3	1706	0.77	3	2348	-0.58	0.10	1.36	19	0612	0.57	19	1206	-0.47	0.03	1.05
4	0524	0.67	4	1142	-0.52	0.08	1.20	19	1818	0.51	20	0054	-0.42	0.05	0.93
4	1748	0.82	5	0000	-0.57	0.13	1.38	20	0718	0.76	20	1242	-0.33	0.19	1.09
5	0630	0.92	5	1224	-0.46	0.23	1.38	20	1924	0.55	21	0100	-0.41	0.09	0.97
5	1836	0.94	6	0054	-0.56	0.20	1.49	21	0736	0.79	21	1342	-0.33	0.22	1.12
6	0706	0.99	6	1330	-0.53	0.24	1.52	21	1930	0.55	22	0118	-0.37	0.10	0.92
6	1930	0.95	7	0124	-0.47	0.25	1.42	22	0824	0.88	22	1412	-0.09	0.36	0.98
7	0754	1.10	7	1418	-0.51	0.29	1.62	22	2000	0.82	23	0218	-0.09	0.35	0.91
7	2036	0.84	8	0230	-0.55	0.15	1.39	23	0818	0.93	23	1448	-0.19	0.35	1.12
8	0842	0.99	8	1506	-0.51	0.23	1.50	23	2048	0.56	24	0300	-0.31	0.14	0.87
8	2136	0.74	9	0330	-0.44	0.16	1.18	24	0918	0.64	24	1600	-0.32	0.14	0.97
9	0930	1.05	9	1554	-0.33	0.34	1.38	24	2200	0.37	25	0318	-0.40	-0.01	0.77
9	2218	0.78	10	0354	-0.31	0.24	1.08	25	0954	0.53	25	1648	-0.31	0.10	0.84
10	1030	0.94	10	1700	-0.24	0.34	1.18	25	2236	0.38	26	0400	-0.24	0.06	0.62
10	2336	0.76	11	0600	-0.14	0.30	0.91	26	1100	0.65	26	1706	-0.17	0.22	0.82
11	1154	0.96	11	1842	-0.10	0.42	1.06	26	2300	0.56	27	0530	-0.01	0.26	0.57
12	0018	0.70	12	0648	-0.17	0.27	0.87	27	1124	0.81	27	1830	0.00	0.40	0.82
12	1242	0.87	12	1924	-0.05	0.41	0.91	28	0018	0.62	28	0624	-0.01	0.31	0.63
13	0148	0.80	13	0742	0.06	0.45	0.74	28	1212	0.77	28	1924	-0.13	0.33	0.90
13	1342	1.01	13	2030	0.06	0.54	0.95	29	0130	0.53	29	0712	-0.11	0.21	0.64
14	0218	0.85	14	0830	-0.05	0.41	0.90	29	1412	0.81	29	2054	-0.04	0.38	0.85
14	1518	0.90	14	2100	-0.04	0.43	0.94	30	0224	0.78	30	0818	-0.05	0.38	0.83
15	0312	0.84	15	0924	0.01	0.42	0.83	30	1512	0.86	30	2100	-0.22	0.33	1.08
15	1600	0.87	15	2206	-0.17	0.35	1.03	31	0324	0.81	31	0948	-0.13	0.35	0.94
16	0406	0.73	16	1030	-0.17	0.30	0.91								

# 7 Bathymetry

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A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using a Trimble 4000 SSE GPS for positioning, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in September and the survey(s) in October on profile line 188, located 517 m south of the pier.

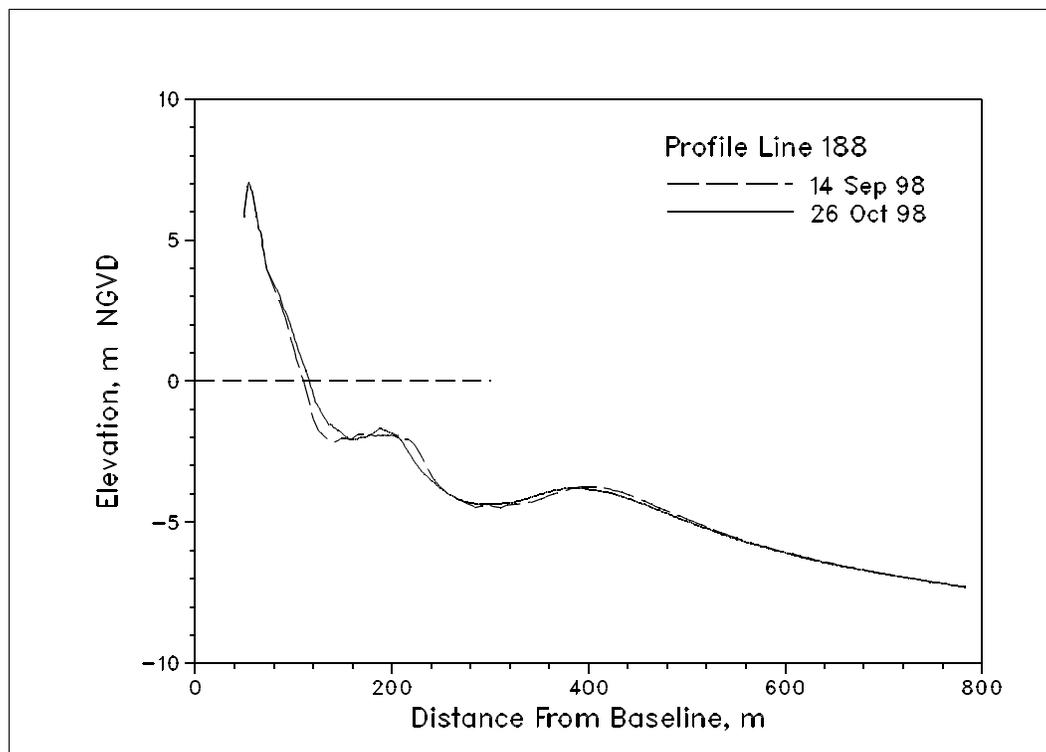


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1998. Cross-hatched areas indicate changes to the annual envelope which occurred in October.

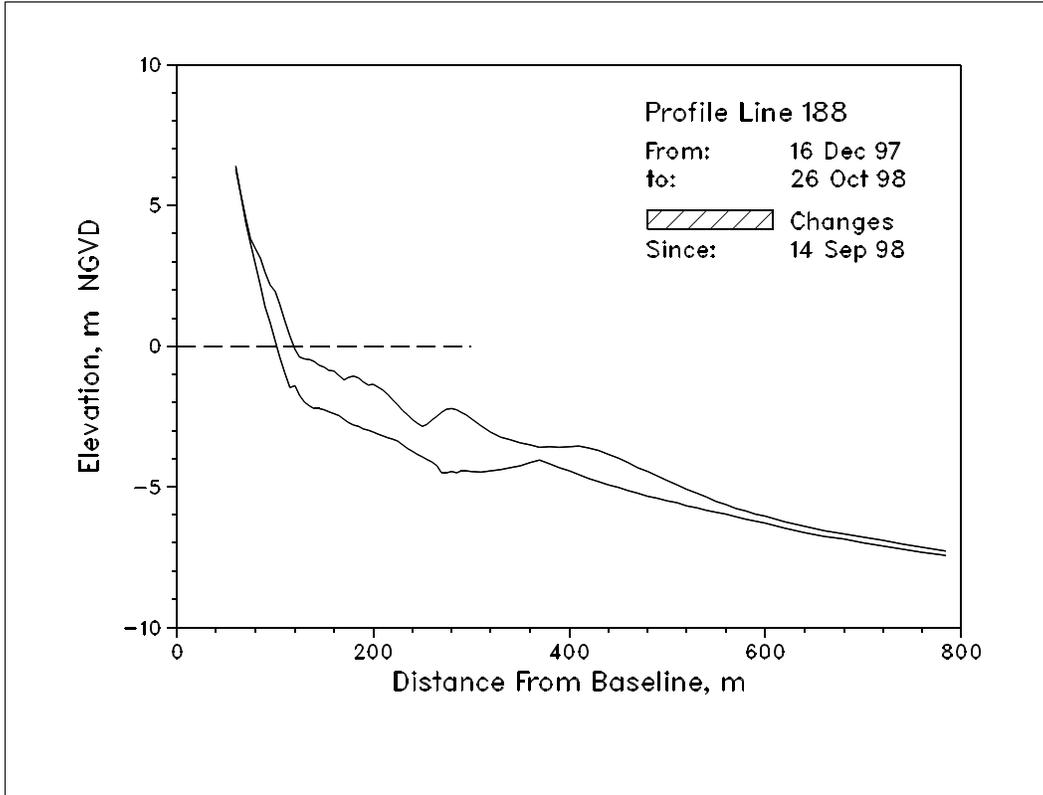


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 26 October. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

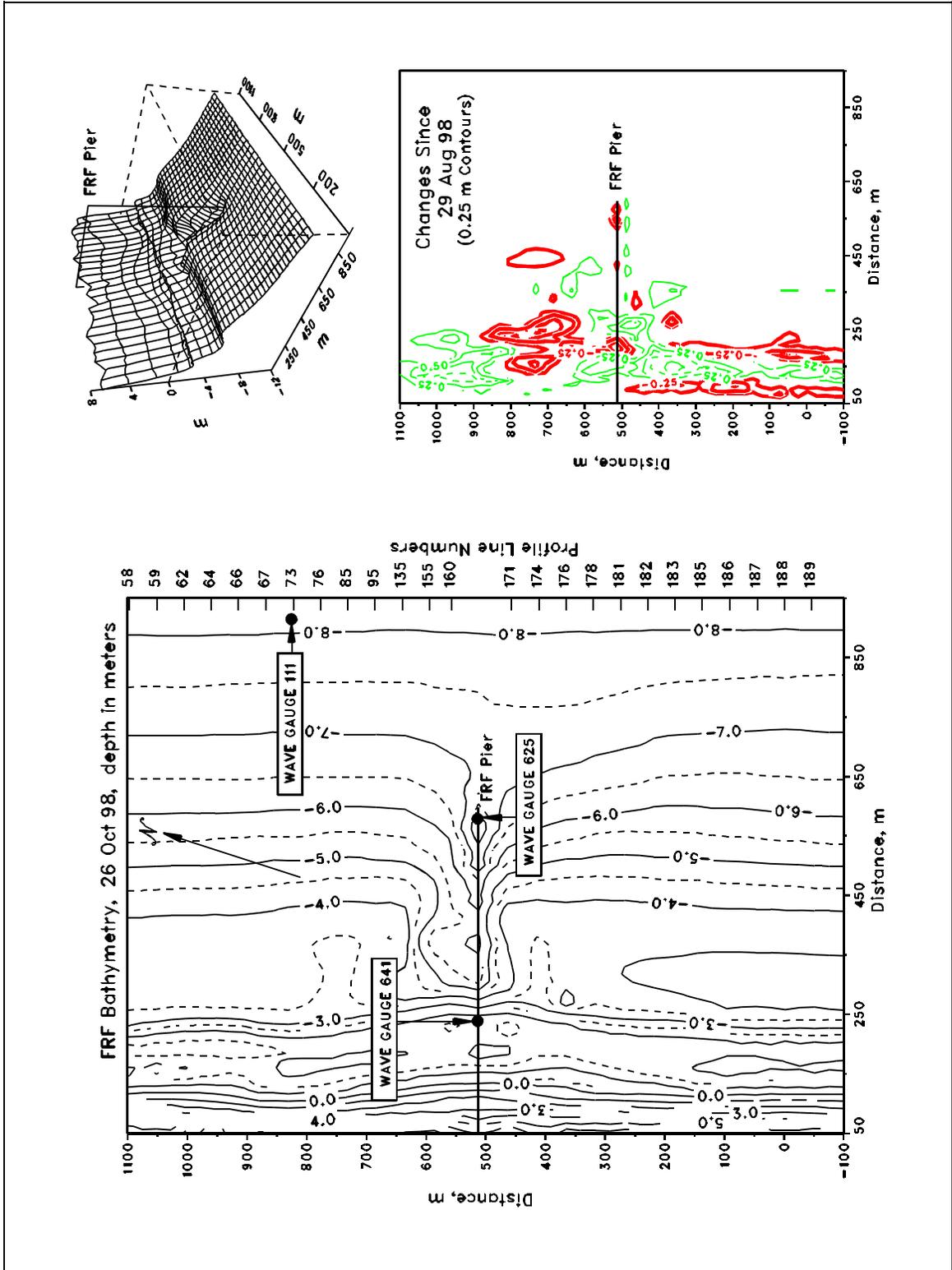


Figure 9. FRF Bathymetry, Depths Relative to NGVD